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Description

Polyphase encapsulated outdoor high-voltage switching device

The invention relates to the field of electrical power distribution and can be used for the design configuration of a polyphase encapsulated, gas-insulated outdoor high-voltage switching device, in which a switch enclosure which accommodates the circuit breaker interrupter units and is arranged flat or horizontally has associated with it, at both ends, line connections which branch off at an angle to the longitudinal axis of the switch enclosure. These line connections may be outdoor bushings, cable connections or busbar connections.

In a known high-voltage switching device of this type, the interrupter units are arranged in a tubular enclosure which can be split centrally and is provided in the region of its ends with sleeves which run transversely with respect to the enclosure axis; each sleeve accommodates an outgoer which is connected to the appropriate pole of an interrupter unit. A piece of tubing is also connected to each sleeve, and a switch disconnector and, possibly, a grounding switch, is arranged in each piece of tubing. A current transformer is arranged around each of the sleeves. A voltage transformer can also be provided between the sleeves and the adjacent pieces of tubing. Finally, a cable termination is intended to be fit to the end of each piece of tubing, as an outdoor bushing. These cable terminations form an essential part of the feeders and outgoers, and include an acute angle between then. - In this high-voltage switching device, the switch enclosure is sealed at one of its end faces by a mounting cover, while the drive for the moveable parts of the interrupter units is arranged at the opposite end. The drive device is in this case also

fixed on a frame, on which the switch enclosure also rests (EP 0 744 758 A2).

For single-phase encapsulated outdoor high-voltage switching devices, an arrangement is known in which a tubular encapsulation enclosure, which is arranged horizontally and contains an interrupter unit for a circuit breaker, has associated with it at each of its two ends an outdoor bushing which is arranged on a separate foundation, and in which, for connection of the respective outdoor bushing, a further encapsulation enclosure, which runs obliquely with respect to the axis of the encapsulation enclosure, is arranged at each of the ends on the encapsulation enclosure (DE-U 9417477.6). - In another known, single-phase encapsulated outdoor high-voltage switchgear assembly, three switching units, which are electrically and mechanically connected to one another, are arranged in a row or parallel to one another. In this case, the encapsulation enclosure of each horizontally arranged circuit breaker has associated with it, at both ends, adjacent encapsulation modules which are fit with a current transformer, and to each of which a switch disconnector is connected which changes the direction of the current path vertically. The adjacent disconnector modules of two switching units are connected to one another via an additional module, to be precise either via an encapsulation module which is fit with an outdoor bushing, or via a line connection which is connected to an outdoor bushing. An outdoor bushing is fit directly onto each of the disconnector modules at both ends of the three series-connected switching units (DE 2929054 A1).

Against the background of a polyphase encapsulated, gas-insulated outdoor high-voltage switching device having the features of the precharacterizing clause of patent Claim 1, the invention is based on the object of designing the switching device to be variable, and in this case to

ensure that it has as little physical height as possible.

In order to achieve this object, the invention provides that the drive device is arranged to the side of the switch enclosure, via a rotary bearing which is arranged in the casing region of the switch enclosure, in order to introduce the drive forces into the switch enclosure, and in that the switch enclosure is provided at the ends with connecting flanges for connection of further encapsulation modules, in which case at least two modules are arranged as further encapsulation modules in order to change the direction of the electrical connections of the interrupter units into the branching line connections.

This refinement of the switching device thus essentially provides for the tubular shape of the switch enclosure to be modified as little as possible and for the rest of the components associated with the switching device to have individual encapsulation modules associated with them, which are connected to the switch enclosure at the ends, in the horizontal direction. To this end, it may be expedient to split the switch enclosure asymmetrically and transversely, in which case the external diameters of the connecting flanges of the switch enclosure are less than the external diameter of the switch enclosure. This, for example, opens up the possibility of the axially shorter part of the switch enclosure also being in the form of a current transformer module, as is known in principle from the part 1 in Figure 1 of DE 298 06 652. In addition, a further current transformer can be integrated in the switch enclosure, at its other end. However, the switch enclosure can also be split transversely in such a manner that two axially shorter parts are associated with both ends with one axially longer part, with the external diameter of the connection flanges for connection of further encapsulation modules being less than the external diameter of the switch enclosure,and in that at least

one of the axially shorter parts of the switch enclosure is in the form of a current transformer module.

The central feature for the invention is that two modules are generally provided as further encapsulation modules and are used to change the direction of the electrical connections of the circuit breaker poles into the line connections which branch off at an angle. These direction-changing modules can in this case contain combined disconnector-grounding switches in a manner known per se (DE-196 32 574 A1, DE 198 25 386 C1). In addition, a cable connection module or a tubular encapsulation module of a horizontally running three-phase busbar can be connected to the direction-changing modules; at least one of the two direction-changing modules may also be in the form of a splitting module with connections, which branch off upwards in a spread manner, for outdoor bushings. In this case, a splitting module with connections which branch off upwards in a spread manner for outdoor bushings can be fit to the second direction-changing module. This is particularly worthwhile if it is also intended to connect a fast-action grounding device module to the direction-changing modules. - The association between the differently designed or differently fitted direction-changing modules and the two ends of the tubular switch enclosure may be configured as required. One arrangement which is particularly expedient for practical requirements is for a vertically aligned direction-changing module, which is in the form of a disconnector-grounding device module, to be arranged at each of the two ends of the switch enclosure, and for a splitting module having connections which branch off upwards in a spread manner for outdoor bushings to be fit to each direction-changing module, with the outdoor connections of the respective splitting module lying in a common plane, which is inclined to the vertical. Such a switchgear assembly can provide a space-saving

replacement for switchgear assemblies which in the past have been constructed in covered rooms from components of previously normal outdoor switchgear assemblies which were not encapsulated. - The novel switchgear assembly can also be used in a simple manner to provide a simple busbar, running in two planes arranged one above the other, with a circuit breaker longitudinal coupling. In this case, a tubular encapsulation module of a horizontally running section of the three-phase busbar is then connected to the one direction-changing module of the switching device, and a further identical direction-changing module is connected to the other, vertically aligned direction-changing module, adjacent to it and above it, and is then used for coupling the second, second busbar section which runs physically parallel to the first busbar section, expediently via an encapsulation tube which runs parallel to the switching device, and an adjacent direction-changing module.

If the direction-changing modules are in the form of splitting modules with connections which branch off upwards in a spread manner for outdoor bushings, then the splitting modules can be designed such that the outdoor bushings lie in a common vertical plane. In this case, it is recommended that the splitting module be designed on the basis of the arrangement which is known from DE 298 06 652, such that each angled splitting module is in the form of a short hollow cylinder, from which an enclosure region which widens in the form of a funnel branches off radially and merges into three connecting flanges, with the connecting planes of these connecting flanges resting tangentially against a part of a circle which runs concentrically with respect to the axis of the splitting module. - However, the connecting flanges may also be arranged such that the outdoor bushings do not lie in a common plane, but are spread apart in different directions in such a manner that the free ends of the outdoor bushings are at the same height.

The arrangement of further encapsulation modules in addition to the direction-changing modules is also feasible for integration of voltage transformer modules in addition to integration of switch disconnectors and grounding switches and combined switch disconnector grounding switches. A disconnector module or a disconnector-grounding device module can be arranged on one side or both sides of the switch enclosure, between a connection flange of the switch enclosure and an angled direction-changing module. A voltage transformer module is then expediently radially connected to the disconnector module or to the disconnector-grounding device module. Three-phase dielectric bushings, which may also be compartmentalized, are also expediently integrated in the last-mentioned modules.

The arrangement of further encapsulation modules on the end faces of the switch enclosure provides the possibility for the switch drive to be arranged in a space-saving manner at the side of, or preferably underneath the switch enclosure. In this case, the switch drive is coupled to the moveable parts of the interrupter units via a rotary bearing which is arranged in the casing region of the switch enclosure as is normal, for example, for outdoor circuit breakers. To this end, the drive device is expediently mounted on a mounting flange in the casing region of the switch enclosure, and is coupled via separate lever drives for the individual interrupter units to their moveable contact pieces; in this case, the rotary bearing is then arranged in a drive housing connected to the mounting flange, while each lever drive has a two-armed direction-changing lever, whose rotary bearing is supported in an insulated manner on the casing of the switch enclosure. - The switch enclosure can be provided with an additional mounting opening in its casing region.

The variability of the novel outdoor high-voltage switching device can be improved even

further if further encapsulation modules are arranged between a connection flange of the switch enclosure and one of the two angled direction-changing modules, which are preferably in the form of splitting modules with connections which branch off upwards in a spread manner for outdoor bushings, at least one of which encapsulation modules is used to change the direction of the current path through 90° in a horizontal plane. This provides the possibility of upgrading the switching device in such a manner that two or more outdoor high-voltage switching devices can be arranged in what is referred to as an H-circuit. The further encapsulation modules are thus essentially disconnector-grounding device modules and additional circuit breaker modules. In particular, it is expedient to provide three disconnector-grounding device modules, which are arranged diagonally opposite one another at right angles, as further encapsulation modules, the central one of which is connected via an additional circuit breaker module to a second outdoor high-voltage switching device which has an identical construction and is arranged in mirror-image form. In this case, what is referred to as a cruciform module, as is normal for encapsulated, gas-insulated high-voltage switchgear assemblies, is expediently used as a module for changing the direction of the current path through 90° in a horizontal plane, and which contains a three-phase combined switch disconnector/grounding switch as is known, for example, from German utility model specification 298 06 211.9. In addition and specifically, a voltage transformer module can be flange-connected to this cruciform module.

A modification of the invention furthermore provides the possibility of flange-connecting the module for changing the direction of the current path through 90° in a horizontal plane axially to the angled splitting module rather than arranging it between the switch enclosure and one of the two angled splitting modules.

The refinement of the outdoor high-voltage switching device provided according to the invention also allows a switching device designed in a corresponding manner to be used either as a longitudinal coupling for coupling transformers in the course of an overhead line or a gas-insulated busbar, or as a transverse coupling for feeding a double overhead line system into a transformer station.

Exemplary embodiments of the novel outdoor high-voltage switching device are illustrated in Figures 1 to 17, in which:

Figures 1 and 2 show a side view and an end view of a first exemplary embodiment having two direction-changing modules in the form of splitting modules,

Figures 3 and 4 show a variant of Figure 1 for the switch enclosure with a flange-connected drive device, showing the drive movement,

Figure 5 shows a variant of Figure 1 with a switch enclosure as shown in Figure 3,

Figure 6 shows a second variant of Figure 1, in this case with cable connection modules which are flange-connected to the direction-changing modules,

Figure 7 shows a third variant of Figure 1, in this case with a direction-changing module for connection of a horizontally running section of an encapsulated busbar,

Figure 8 shows a fourth variant of Figure 1, in which the switching device is in the form of a longitudinal coupling in the course of an encapsulated simple busbar,

Figure 9 shows a fifth variant of Figure 1, in this case with a splitting module fitted to a direction-changing module, and

Figure 10 shows a sixth variant of Figure 1, in this case with two splitting modules fitted to direction-changing modules, whose outdoor bushings are arranged inclined to the vertical step.

Figure 11 shows a switchgear assembly having a number of circuit breakers and having direction-changing modules associated with the circuit breakers, in order to change the direction of the current path through 90° in a horizontal plane, in order to provide what is referred to as an H-circuit,

Figures 12 to 15 shows various modifications of the switch gear assembly shown in Figure 11,

Figure 16 shows an H-circuit having two cable outgoers, and

Figures 17 and 18 show an H-circuit in the form of a double outgoer.

Figures 1 and 2 show an outdoor high-voltage switching device in which a switch enclosure 1 is arranged lying horizontally on a frame 2. The switch enclosure 1 is split transversely and asymmetrically, thus resulting in a longer enclosure part 11 and a shorter enclosure part 12. The two enclosure parts are provided with a respective connecting flange 13 or 14, with the external diameter of the respective connecting flange being less than the external diameter of the switch enclosure 1. Three interrupter units are arranged, preferably diagonally opposite, in the switch enclosure in a manner which is not illustrated. The switch enclosure may be oval, if required. - The enclosure part 12 may at the same time be used as an encapsulation module for accommodating a current transformer, as is known per se from DE 298 05 945 U.

An encapsulation module is flange-connected to the switch enclosure 1 or to its enclosure part 12, this encapsulation module 4 being an angled splitting module for changing the direction of the electrical connections of the circuit breaker poles into the outdoor bushings 45 which branch off in a spread manner. For this purpose, the encapsulation module, which is in the form of a short hollow cylinder 41, merges into an enclosure region 42 which widens radially in the form of a funnel and ends in three connecting flanges 43. The connecting planes of these

connecting flanges rest tangentially against a part of a circle 44, in which case this part of a circle is arranged concentrically with respect to the axis of the splitting module, and hence with respect to the axis 15 of the switch enclosure 1. In the illustrated embodiment, the outdoor bushings 45 lie jointly in a vertical plane.

A second angled splitting module 4 is arranged at the other end of the high-voltage switching device. An encapsulation module 5 is located between this second splitting module 4 and the connecting flange 13 of the enclosure part 11 and accommodates a combined switch disconnector/grounding switch, which is not illustrated in any more detail, in a known manner. Such a switch is known in principle (DE 36 08 482 C2, EP 0 128 377 A2) and is also described in a prior patent application (DE 198 16 360.6). The encapsulation module 5 also has a radially arranged connecting flange 51, to which a voltage transformer 6 is flange-connected. - An identical encapsulation module 5 can also be arranged between the enclosure part 12 and the associated angled splitting module 4. - In the simplest case, the high-voltage switching device essentially comprises only the switch enclosure 1 which accommodates the circuit breaker interrupter units, and two splitting modules 4 which are flange-connected at the side.

A housing 3 is also arranged underneath the switch enclosure 1, is mounted on the frame 2 and, in addition to the switch and assembly controller, accommodates a drive device, which is not shown in any more detail, for driving the moveable parts of the interrupter units which are arranged in the switch enclosure 1. For this purpose, parts of a lever drive are articulated on the moveable parts of the interrupter units through the casing of the switch enclosure 1, or through a flange arranged in the casing region.

Figure 3 shows a circuit breaker module 25 whose switch enclosure is split transversely in such a manner that two axially shorter enclosure parts 15 and 16 are associated with an axially longer part 17. The enclosure parts 15 and 16 have an identical construction and are used, inter alia, as current transformer modules, of which the secondary connecting region 76 can in each case be seen. The enclosure parts 15 and 16 are also used as adapters between the tubular enclosure part 17 and the adjacent encapsulation modules, in which case the connection flange facing the enclosure part 17 has a larger external diameter than the connection flange associated with the adjacent encapsulation module.

The poles 26 and 27 of one of the three circuit breaker poles are indicated in outline form within the enclosure part 17, with each circuit breaker pole being supported on the tubular enclosure wall of the enclosure part 17 via a respective hollow insulating support 28 or 29. For this purpose, the pole 26 has an associated traverse 77 in the region of an enclosure flange 18. An enclosure 19 is flange-connected to the enclosure flange 18, accommodates a direction-changing drive and, as shown in Figure 4, is at the same time provided with a supporting flange 34 for a drive device 35. The drive device 35 contains a spring energy-storage drive 36, which acts on a direction-changing lever 39 via a direction-changing lever 37 and a coupling rod 38. The rotary bearing of this direction-changing lever is mounted in the enclosure 19 in such a manner that one of its lever arms is located inside the enclosure 19. A vertically moveable coupling rod 70 is articulated on this lever arm. On each of the circuit breaker poles which are provided in the switch enclosure 17 and have a moveable switching contact, this coupling rod acts via a respective coupling element 78 on a direction-changing lever 71, whose rotary bearing 82 is mounted in the enclosure of the pole 26, and which itself drives the axially moveable

contact piece 74 of the pole 26 via a first coupling rod 72 which can pivot, and via second coupling rod 73 which is guided axially. The second coupling rod 73 for this purpose is seated in a sliding manner on a horizontally running guide rod 75, and also accommodates the pivoting bearing for the first coupling rod 72.

Figure 5 shows the view of a switchgear assembly which has only one circuit breaker module 25 with the enclosure parts 15, 16 and 17 and, at each end of this circuit breaker module, an encapsulation module in the form of a splitting module 4 with connections, which branch off upwards in a spread manner, for outdoor bushings 45.

As shown in Figure 6, a circuit breaker module 25 with the enclosure parts 15, 16 and 17 has a respectively associated direction-changing module 60 or 61 at each end, which changes the direction of the current paths through 90° downwards and is at the same time in the form of a combined disconnector/grounding device, and is also provided with a fast-action grounding device 64. A cable connection module 46 is flange-connected to each of these direction-changing modules. The direction-changing module 60 also has an associated voltage transformer 6.

Figure 7 shows a circuit breaker module 25 to one end of which a direction-changing module is connected, which is in the form of a splitting module 4 and is fit with outdoor bushings 45. A voltage transformer 6 is axially connected to this direction-changing module. - A direction-changing module 47 is arranged at the other end of the circuit breaker module and changes the direction of the current paths through 90° in the horizontal plane, and is intended for connection of a three-phase encapsulated busbar.

As shown in Figure 8, a circuit breaker module 25 has an associated direction-changing module 47 at the right-hand end for connection of a three-phase

encapsulated busbar; at the same time, a voltage transformer 6 is flange-connected to this direction-changing module. A direction-changing module 48 is arranged at the left-hand end of the circuit breaker module and changes the direction of the current path vertically through 90° upwards. An identical module 48 is fit to it, and an extension module 7 in the form of a three-phase encapsulated busbar is connected horizontally to the this module 48. A direction-changing module 47 is arranged on this extension module, changes the direction of the current path through 90° in the horizontal direction, and is used for connection of a busbar. This second direction-changing module 47 is also fitted with a voltage transformer 6. - In this refinement of the invention, the switchgear assembly is used as a longitudinal coupling in the course of an encapsulated simple busbar.

According to Figure 9, the direction-changing module 60 which is arranged at the right-hand end of a circuit breaker module is used to change the direction of the current path through 90° upwards, and is at the same time in the form of a combined disconnector/grounding device. Furthermore, a voltage transformer 6 is flange-connected to this direction-changing module 60 underneath, and a fast-action grounding device 64 is flange-connected to it axially on the right. The direction-changing module is fit on the flange which projects upwards with a splitting module 49, which is provided with three connecting flanges to which outdoor bushings 45 are fit. In this case, the outdoor bushings lie in a common vertical plane.

According to Figure 10, a direction-changing module 60 or 61 for changing the direction of the current path through 90° upwards is fit to each end of a circuit breaker module 25, with these direction-changing modules at the same time being in the form of a disconnector/grounding devices. A splitting module 54

is fit to both direction-changing modules, with the connections 55 for outdoor bushings 45 each lying in a common plane, which is inclined to the vertical. - A voltage transformer 6 and a fast-action grounding device 64 are also flange-connected to the direction-changing module 60.

Figure 11 shows an outdoor high-voltage switching device in which two switching devices as shown in Figure 1 are arranged parallel to one another, with each switching device essentially comprising a circuit breaker module 25, a disconnection/grounding device module 50 or 51 and two angled splitting modules 30 and 31, and 32 and 33 respectively. The two modules 31 and 33 have respective encapsulation modules 60 and 61 connected to them, which are used to change the direction of the current path through 90° in a horizontal plane. For this purpose, the modules 60 and 61 are in the form of combined disconnection-grounding device modules, as are known per se from the prior art. A voltage transformer 6 is fit to each module 60 and 61. - The two modules 60 and 61 are coupled to one another via a third circuit breaker module 25, which is connected firstly directly to the module 61, and secondly via an extension module 7 to the module 60.

According to Figure 12, the switchgear assembly shown in Figure 11 can also be constructed, while operating in the same way, such that the splitting modules 31 and 33 are flange-connected to the direction-changing modules 60 and 61. - According to Figure 13, additional disconnection-grounding device modules 62 and 63 can in this case be arranged.

According to Figure 14, three circuit breaker modules 25 are arranged between the two angled splitting modules 30 and 32, with their association being arranged with the aid of the direction-changing modules 60 and 61, respectively. In this case, three-phase pipeline sections 8 and 9, respectively, which lead to corresponding power connections, are

flange-connected to the direction-changing modules 60 and 61, rather than splitting modules.

Figure 15 shows a complete circuit that is referred to as an H-circuit, in which two separate overhead line systems OHL 1 and OHL 2 are coupled to one another via a first outdoor high-voltage switching device comprising the circuit breakers 20 and 23, the splitting modules 30 and 31, the disconnector-grounding device modules 50 and 52 and the direction-changing module 60, and via a second outdoor high-voltage switching device comprising the corresponding modules 21, 24, 32, 33, 51, 53 and 61, via the cross-connection 7 and the circuit breaker module 22, and have two associated transformers T_1 and T_2.

The outdoor high-voltage switching device as shown in Figure 16 has three circuit breaking modules 25 which are arranged in a U-shape and are connected to one another via combined disconnector-grounding device modules 5 and two encapsulation modules 60 and 61, with the direction-changing modules 60/61 changing the direction of the current path through 90° in the horizontal direction, and being in the form of disconnector-grounding device modules. A direction-changing module 48 is in each case flange-connected to those modules 5 which are immediately adjacent to the central circuit breaker module 25 and is used to change the direction of the horizontally running current path through 90° downwards, and to which cable connection modules, which are not shown in any greater detail, are flange-connected.

Figure 17 shows a side view and Figure 18 a plan view of two overhead line systems OHL 1 and OHL 2, to which a high-voltage switching device in the form of a double branch is connected. To this end, a splitting module 4 is first of all connected to each overhead line system via overhead line bushings 45 and is used to change the direction of the current path in a horizontal plane, and to which a respective direction-changing module 60 or 61 is connected in

order to change the direction of the current path through 90° in a horizontal plane. This direction-changing module is at the same time in the form of an integrated disconnector-grounding device module. From the modules 60 and 61, respectively, it passes via encapsulated tubular line sections 75 to a T-shaped encapsulation module 65, which is provided with an integrated angled disconnector-grounding device, and which is at the same time connected to the respective other direction-changing module 4. From the encapsulation modules 65, it passes via an encapsulated tubular line section 76 to the respective circuit breaker module 25, to which a respective splitting module 56 or 57 is connected directly or with the interposition of a longitudinal disconnector-grounding device 5, with the respective splitting module 56 or 57 being provided with connections which branch off upwards in a spread manner for outdoor bushings 45. A transformer or a further overhead line system can be connected to the outdoor bushings. Alternatively, it is also possible to connect a cable system by using an appropriate direction-changing module.